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Canadian Science Advisory Secretariat
Newfoundland and Labrador Region | Science Advisory Report 2018/031

AN ASSESSMENT OF ICELAND SCALLOP IN THE CANADA-FRANCE TRANSBOUNDARY ZONE OF ST. PIERRE BANK

Image. Iceland Scallop (Chlamys islandica).

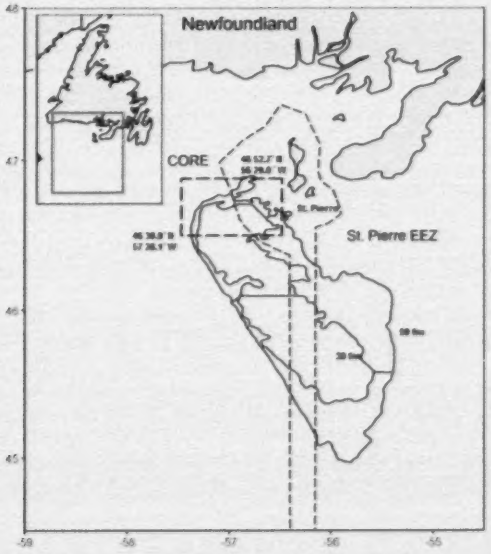

Figure 1. Northern St. Pierre Bank showing the Canada-France Transboundary (CORE) Zone.

Context:

The directed fishery for Iceland Scallops (Chlamys islandica) *started on St. Pierre Bank in 1989. Populations off Newfoundland and Labrador are normally found in waters from 50-200 m, usually on hard bottom with variable substrate composition, consisting largely of sand, gravel, shell fragments, and stones.*

Prior to 1996 the entire catch was taken by Canada. A decision by an International Court of Arbitration in 1992 resulted in jurisdictional changes over the disputed waters to the south of Newfoundland and St. Pierre and Miquelon. Following that decision, an annual total allowable catch (TAC) level has been established for an area called the "Transboundary Zone" or simply the "CORE" (Fig. 1). Joint TACs have been in place for the CORE since 1995. France and Canada are allocated a fixed percentage of the TAC, 70% and 30% respectively.

This Science Advisory Report is from the February 20, 2018 Assessment of Iceland Scallop on St. Pierre Bank. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

June 2018

Canada

SUMMARY

- Directed fishing started in 1989 and peaked at 6,000 t in 1992. There has been no fishing from 1997 to 2016 with minimal fishing activity in the CORE area in 2017, where the Total Allowable Catch (TAC) is 1,650 t (total).
- A Canadian research survey in September 2017 resulted in a minimum dredgeable biomass estimate of 1,200 t which is among the lowest in the survey time series, and a decrease of approximately 60% since 2009.
- Mean shell height is consistently higher in Canadian waters than in French waters.
- An average meat count of 85 scallop/500 g from the 2017 survey was the highest in the survey time series.
- Predatory sea stars were observed at the lowest level in the survey time series in 2017.
- The annual natural mortality estimate in 2017 was 7%, the lowest in the time series.

BACKGROUND

Biology

The Iceland Scallop (*Chlamys islandica*) is widely distributed within the subarctic but is also found in fishable aggregations as far south as the coast of Massachusetts. Populations off Newfoundland and Labrador are usually found at depths of 50-200 m, predominantly on hard substrates, consisting largely of sand, gravel, shell fragments, and stones. The Iceland Scallop is a filter-feeder, consuming plankton and detritus, and is associated with areas of strong currents. To reside in such areas, the scallop is attached to the substrate by a byssal thread. Unlike other scallops the byssus is maintained to the adult stage.

Iceland Scallop are dioecious (having separate sexes), become sexually mature at 3-6 years of age, and fully recruit to the commercial fishery at 60 mm shell height (about age 9). Spawning in Newfoundland waters begins in April – May and is thought to be initiated by short-term variation in temperature. Eggs are externally fertilized and larvae are planktonic for as long as 10 weeks before settling to the bottom, possibly at considerable distances from the spawning adults. Iceland Scallop frequently live more than 25 years, but seldom exceed 100 mm in shell height.

Fishery

Directed fishing started in 1989 and peaked at 6,000 t in 1992 (Table 1). Prior to 1996 the entire catch was taken by Canada. In 1992, the decision by an International Court of Arbitration resulted in jurisdictional changes over the disputed waters to the south of Newfoundland and St. Pierre and Miquelon. Following the decision, an annual catch level (TAC) was established for an area called the "Trans-boundary Zone" or simply the "CORE" (Fig. 1). France and Canada are allocated fixed percentages of the TAC at 70% and 30% respectively. Joint TACs were first established for the CORE in 1995 at 2,800 t. However, less than 10% of the TAC was taken in any one year from 1995 to 1997. There was no fishing between 1997 and 2016, with minimal fishing activity in the CORE area in 2017. A TAC of 100 t was allocated in 1999-2000, and increased to 400 t in 2001,and then to 1,650 t in 2006, where it has remained since.

Table 1. TACs and removals (tonnes).

Year	Removals (tonnes, 000's)	TAC (Total)
1989	36	-
1990	507	-
1991	755	-
1992	5967	-
1993	0	-
1994	0	-
1995	230	2800
1996	306	3250
1997	122	2100
1998	0	630
1999	0	100
2000	0	100
2001-2005	0	400
2006-2017	**	1650

** Note: 2017 landings are not included in this report for confidentiality reasons.

ASSESSMENT

Research Surveys

Canadian resource assessment surveys were conducted from 1990-93, 1996, 1998, 2005, 2009, and 2017 using a stratified random sampling scheme. Stratification was based on area and depth. Sets were optimally allocated in proportion to stratum-specific areas and variance of the catch rates.

The survey area was reduced in 1991 and the strata were redrawn to focus on aggregations of scallops in the north. Strata were redrawn again in 1993 to accommodate the new Canada-France boundary resulting from the decision by the International Court of Arbitration. All subsequent surveys used this stratification scheme (Fig. 2).

A 12 ft New Bedford scallop dredge equipped with 3" rings and interconnected with 3-top and 4-bottom link configuration was used in the surveys in 1998, and since 2005 an 8 ft dredge has been used. Standard tow length with the 12 ft rake was 1.0 nm and was 0.5 nm with the 8 ft rake. For the Canadian scallop surveys all catch results were standardized to an 8 ft dredge swept area so the results were comparable throughout the survey time series. A scallop survey was also carried out by Department of Biological Resources and Environment, France (IFREMER) in 2011 on the Marcel Angie (20 m commercial vessel) using a 10 ft New Bedford scallop dredge (Foucher and Goraguer 2012). Upon completion of each tow (set) dead scallops with non-disarticulated valves ("cluckers") and live scallops, as well as sea stars, were sorted by species for all surveys. Total catches were enumerated and weighed by species.

Shell height of scallops was determined from each set based on either the total catch or a sub-sample. Meat yield samples (number of meats per 500 g) were collected during all

Canadian surveys from most or all strata. Strata 11 and 22 were sampled all years except for in 2017, when stratum 11 was not sampled.

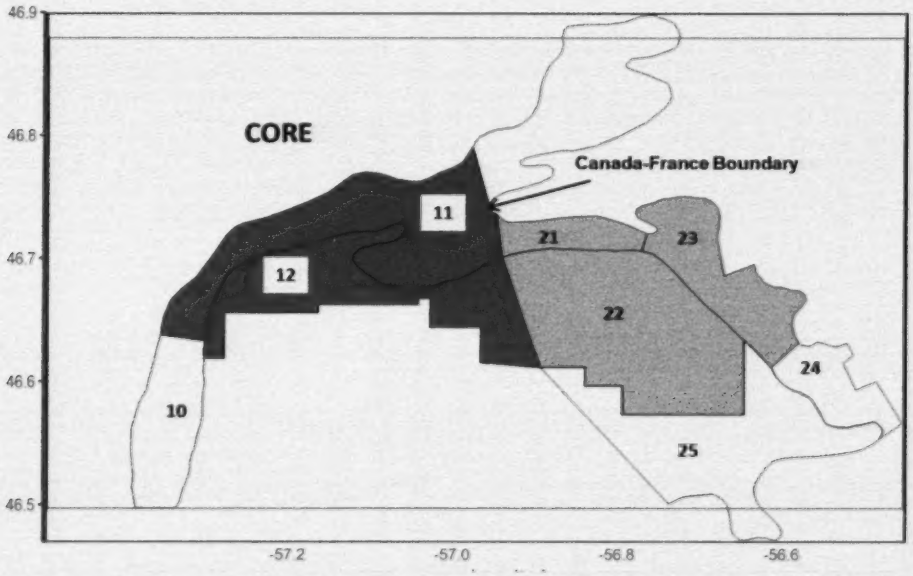

Figure 2. Northern St. Pierre Bank showing the main "commercial" strata (shaded) for Iceland Scallop.

Biomass

In past Iceland Scallop assessments, scallop survey minimum dredgeable biomass (MDB) and abundance indices were calculated using STRAP analysis (Smith and Somerton, 1981). In this assessment Ogive Mapping (Ogmap) (Evans 2000) was introduced as the spatial expansion platform to determine the (MDB) and abundance estimates. Ogmap is a spatial expansion method that is used to extrapolate across poorly sampled areas and in some years produces narrower confidence intervals (97.5%, CIs). As shown in Fig. 3, when comparing the (MDB) estimates from the Canadian Scallop Surveys that took place between 1993 and 2017 based on STRAP and Ogmap analysis, the trend is similar.

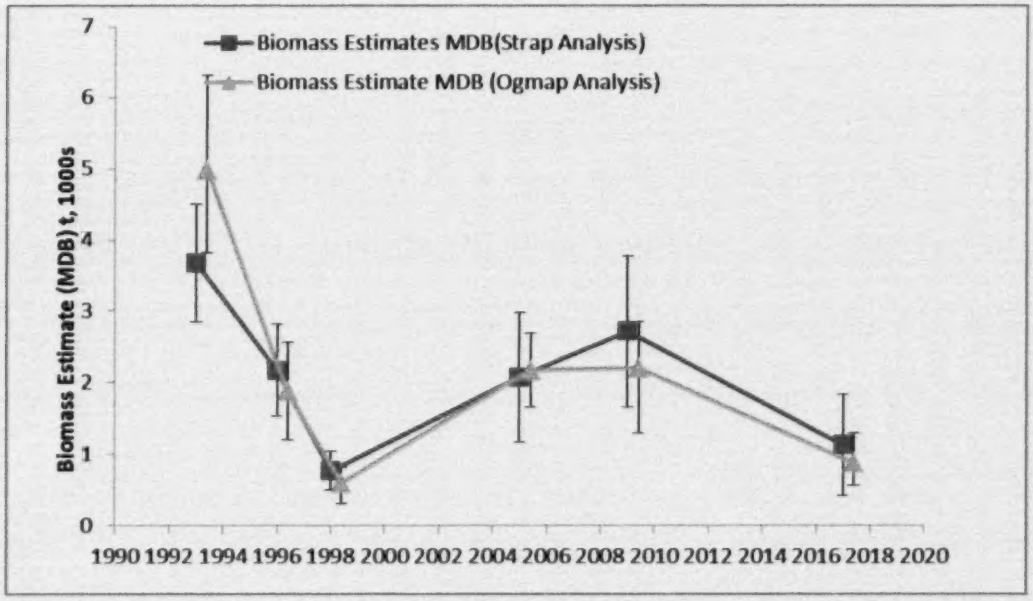

Figure 3. Comparison of the minimum dredgeable biomass (MDB) estimates based on Ogmap analysis and STRAP analysis from the Canadian Scallop Surveys between 1993 and 2017 for the main commercial strata (strata 11, 12, 21, 22, 23).

Table 2. Minimum dredgeable biomass (MDB) estimates (using Ogmap Analysis) for the CORE area and the main commercial strata (based on Canadian Scallop Survey data).

Year	CORE Area (n. mi^2)	CORE MDB (t, 1000s)	Commercial Strata Area (n. mi^2)	Commercial Strata MDB (t, 1000s)	Commercial Strata % of Total MDB
1993	269.1	7.34	187.6	4.98	68
1996	269.1	2.51	187.6	1.88	75
1998	269.1	0.80	187.6	0.60	75
2005	269.1	2.77	187.6	2.17	78
2009	251.1	3.39	187.6	2.20	65
2017	251.1	1.2	187.6	0.87	73

The 2017 MDB estimate (based on Ogmap analysis) of 1200 t is among the lowest in the survey time-series, and reveals a decrease of approximately 60% since 2009 (Table 2, Fig. 4). The overall MDB estimate results for the CORE area also included the 2011 France survey (note: the summary results from the 2011 France survey were included in this report for the CORE area [strata 11&12, 21-25] however, the raw data from the survey were not provided and therefore results for strictly the commercial strata were not included in Fig. 5). Although this biomass estimate was based on all strata, only a few contained the bulk of the scallop biomass. Most of the fishing effort was concentrated in these strata in the past. These main "commercial" strata (11, 12, 21, 22 & 23, Fig. 2) usually account for 70-80% of the entire Iceland Scallop biomass in the CORE area (Table 2). In the commercial strata, the MDB decreased throughout the 1990s to a low of 600 t in 1998 and then increased in 2005 and 2009, due mainly to an increase in MDB in the Canadian zone. The biomass estimate in the commercial strata has declined again in 2017 to a low of 874 t (Table 2).

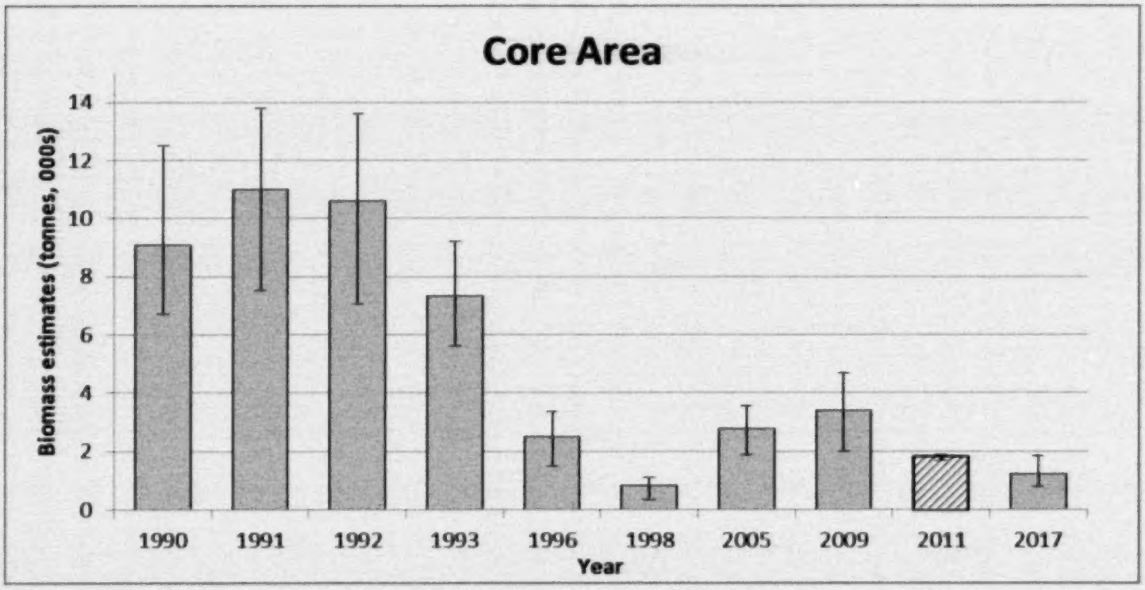

Figure 4. Biomass estimates from all the strata within the CORE area (strata 10-12, 21-25) from the Canadian Surveys, and 2011 France Survey. Note the 2009 and 2017 biomass estimates do not include stratum 10.

Between 1993 and 1998, biomass decreased in the French zone and has ranged from 900 t in 2005 to 300 t in 2017 (Fig. 5). The biomass decreased from 2009 to 2017 which seems to be driven by the decline of biomass in the Canadian zone. The percentage of the MDB in the Canadian zone in 2017 is estimated at 56% (Fig. 5).

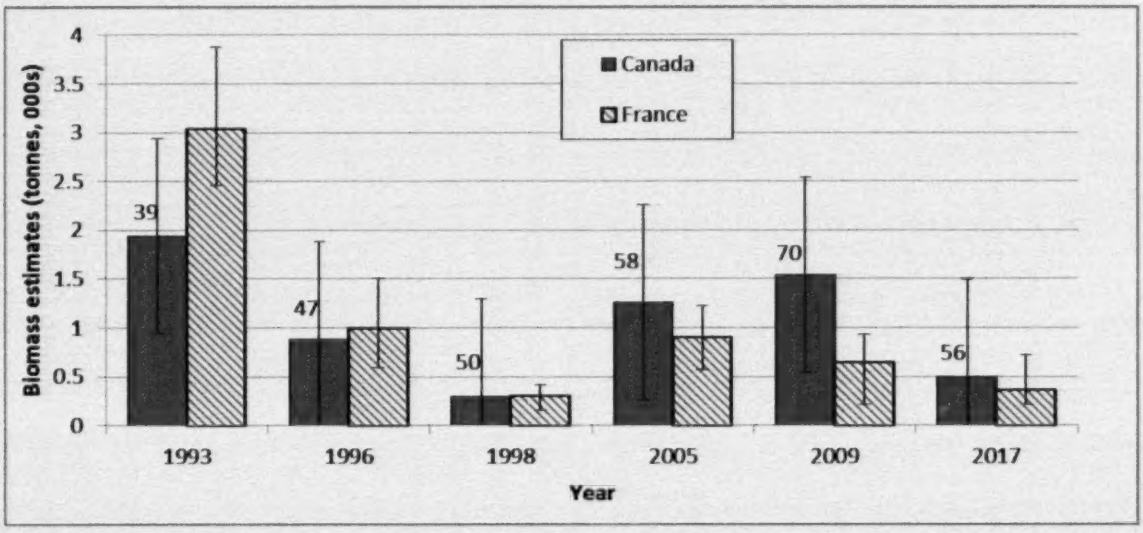

Figure 5. Biomass estimates from commercial strata in the Canadian zone (strata 11, 12) and the French zone (strata 21, 22, 23) based on the Canadian Surveys between 1993 and 2017.

The meat count based on the Canadian surveys increased from 68/500 g in 2009 to 85/500 g in 2017. The 2017 meat count is the highest in the survey time series, which could indicate a reduced yield as there has been no major change in scallop size within the designated areas.

Based on the Canadian survey data the mean shell height is consistently higher in Canadian waters than in French waters. The mean shell height was 79 mm in Canadian waters (strata 11 and 12) in 2009 and 2017, and 65 mm in French waters (strata 21-25) in 2009 and 70 mm in 2017 (Fig. 6).

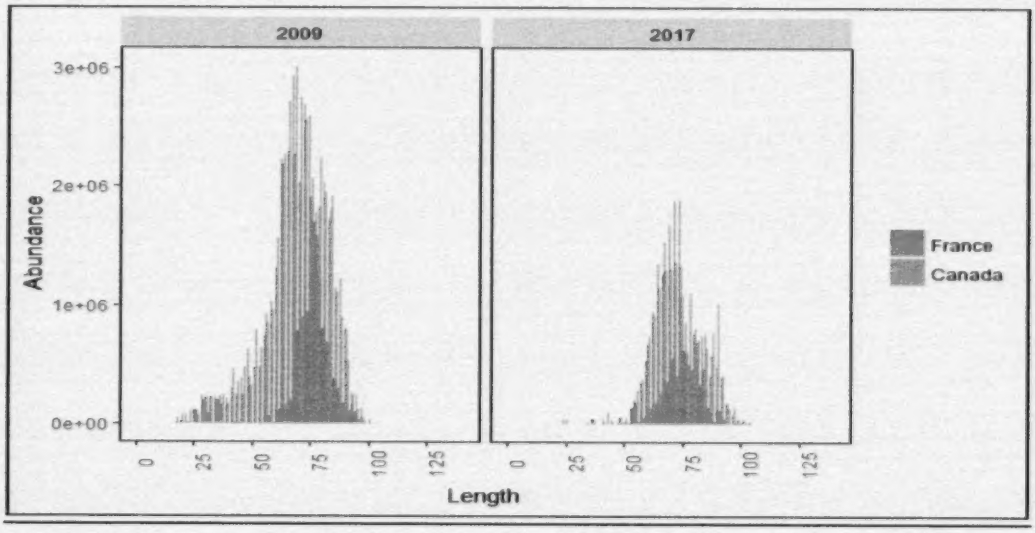

Figure 6. Abundance at length (shell height) in 2009 and 2017 broken down between strata in Canada (strata 11-12) and France (strata 21-25).

Mortality

The natural mortality index (computed as the proportion of cluckers to live scallops) (Naidu 1988) was relatively low (15%) in the early 1990s and increased throughout that decade. This index since decreased from a high of 88% in 1998 to 7% in 2017 (Fig. 7).

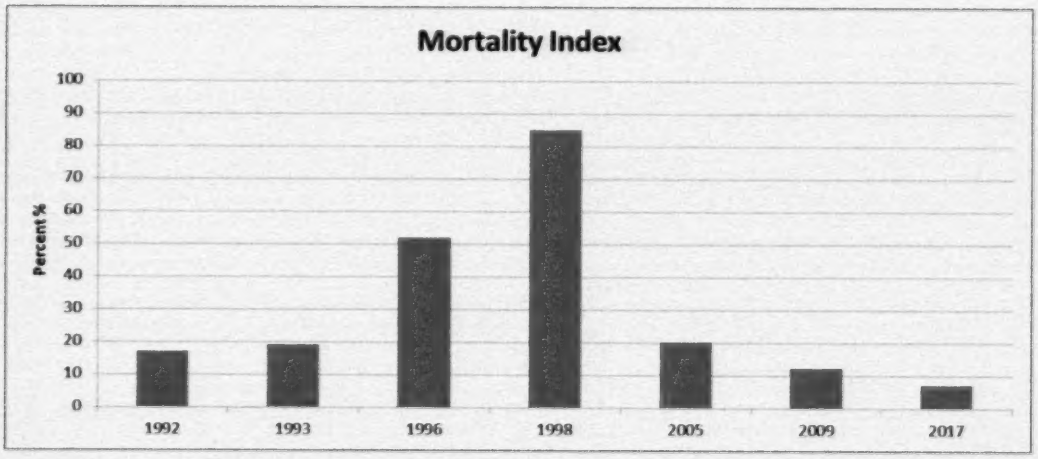

Figure 7. Mortality Index for Iceland Scallop in the Core area.

Predation

In the early to mid-1990s a high abundance of predatory sea stars contributed to significant mortality in Iceland Scallop in the CORE area (Lawrence et al. 1997; Naidu et al. 2001). The change in spatial distribution of the scallop biomass between 1993 and 2005 was associated with a high biomass of sea stars within stratum 22 in the French zone during 1996 to 1998. Biomass of all sea star species increased to a high of 1,600 t (MDB) in 1998, when Iceland Scallop biomass was at its lowest (Fig. 8). Since the 1996 survey, sea stars have been enumerated by species. In the French zone, biomass of *Leptasterias polaris* and *Crossaster pappossus*, the two main predatory species on St. Pierre Bank, increased from 1993 to 1998, then decreased to the lowest level in the survey time series in 2017 (Fig. 8).

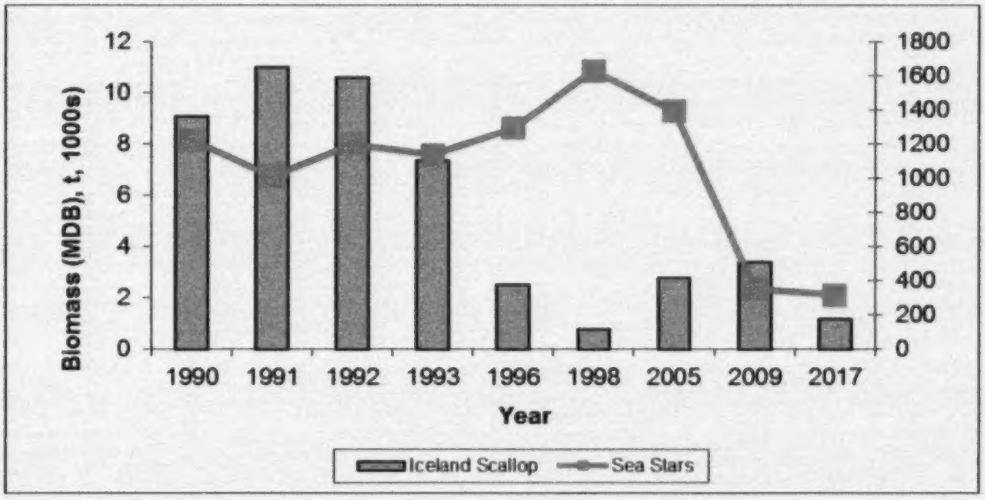

Figure 8. Iceland Scallop and sea star biomass estimates based on Canadian research surveys in the CORE area from 1990 to 2017.

Sources of Uncertainty

The most recent Canadian assessment survey in September 2017 had incidences where the dredge warp-to-depth ratio of 3 to 1 (which is outlined in the scallop survey protocol) was not consistently maintained. A change in warp-to-depth ratio can affect the pitch angle of the dredge, however it is unknown how this would affect the efficiency of the dredge.

The results presented in this report from the 2011 scallop survey should be observed with some caution. These results were based on summary results provided by IFREMER (Foucher and Goraguer 2012). The protocols and methodologies used for analysis are similar to the Canadian surveys; however this data was not standardized or analyzed in conjunction with the Canadian survey data. Even though the sampling protocols are comparable, the vessel and sampling gear used for the 2011 survey differed from that of the Canadian surveys (commercial vessel versus research vessel and utilizing a 10 ft dredge versus a 10 or 8 ft. dredge). In addition, weather was particularly harsh during the 2011 survey which may have negatively affected the efficiency of the sampling gear.

CONCLUSION

The biomass estimate has declined from 3,390 t in 2005, to 1,200 t in 2017, largely due to a decrease in biomass in the Canadian zone. The 2017 survey meat count of 85/500 g was the highest in the survey series despite no major change in scallop size within the designated areas, indicating reduced yield. The 2017 natural mortality index was at a low of 7% which is associated with the lowest level of predatory sea stars observed since the start of the fishery.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 20, 2018 Assessment of Iceland Scallop on St. Pierre Bank. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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